BridgeWave
COMMUNICATIONS

Making connections in a high-speed world

80GHz Wireless Ethernet Links

Installation Manual

P/N 580-00519
Revision D
January 2008

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This publication has been prepared for professional and properly trained personnel, and the customer assumes full responsibility when using the information herein.

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All BridgeWave radio products are restricted commodities that fall under ECCN 5A002 of the Department of Commerce. These products are "ENC restricted" under section 740.17(b)(2) of the Export Administration Regulations (EAR). BridgeWave products may only be exported, re-exported, transferred, or retransferred in accordance with Export Administration Regulations. Diversion contrary to U.S. law is expressly prohibited.

Product Compatibility

While every effort has been made to verify operation of this product with many different communications products and networks, BridgeWave makes no claim of compatibility between its products and other vendors' equipment. Customer is responsible for thoroughly evaluated this product's performance in the communications environment in which it will be used.

Safety

CAUTION, WARNING, and DANGER statements have been placed in the text to alert personnel of possible hazards. These statements must be closely observed.
The following general safety precautions must be observed during all phases of operation and service of the products covered in this manual. Failure to comply with these precautions or with specific warnings elsewhere in this manual willfully violates standards of design, manufacture, and intended use of the product. BridgeWave assumes no liability for the customer's failure to comply with these requirements.

- *The FE/GE/AR80(X) meets all applicable FCC safety requirements for radio equipment; however, it is best to avoid prolonged, unnecessary exposure to the front of the radio while it is operating*

- *The outdoor equipment must be properly grounded to provide some protection against voltage surges and built-up static charges. In the event of a short circuit, grounding reduces the risk of electrical shock.*

  For installations in the U.S.A., refer to Articles 810 830 of the National Electrical Code, ANSI/NFPA No. 70, for information with respect to proper grounding and applicable lightning protection for DC cables.

  For installations in all other countries, implement protection in accordance with the safety standards and regulatory requirements of the country where the equipment is to be installed.

- *Do not install or operate this equipment in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.*

- *Do not install substitute parts or perform any unauthorized modification to the equipment. Changes or modifications not expressly approved by BridgeWave can void the user's authority to operate the equipment.*

Regulatory Information

This device complies with Part 101 of the FCC Rules.
Links installed in the U.S. must be registered with the FCC as provided for in Part 101 of the FCC regulations. For more information contact BridgeWave's Customer Service via E-mail support@bridgewave.com or call at 408-567-6906.

Equipment Precautions

Water and Moisture – The 80GHz System is designed to withstand precipitation conditions typically encountered when installed outdoors.
Power Sources - This product should only be operated with the type of power supply provided by BridgeWave Communications Inc.

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1 Introduction

1.1 Purpose of Manual

The information in this manual is directed to persons who must perform or coordinate the tasks associated with the process of installing wireless communication devices, and planning communication network applications.

1.2 Prior Knowledge

This manual assumes the operator has at least basic experience with and an understanding of wireless technology and some familiarity with configuring and operating networking equipment. Preferably, the person installing this equipment fully understands the information covered in this manual prior to attempting these procedures.
DANGER, WARNING and **NOTE** statements have been placed in various sections throughout this document to alert personnel of possible traffic affecting issues and to provide additional tips and helpful information. These statements should be closely observed.

Symbol	Description
Danger	*Indicates that personal injury can result if the user does not comply with the given instruction.* *A DANGER statement will describe the potential hazard, its possible consequences, and the steps to perform to avoid personal injury.*
Warning	*Indicates that equipment damage, process failure and/or loss of data can result if the user does not comply with the given instructions.* *A WARNING statement will describe the potential hazard, its possible consequences, and the steps to perform to avoid serious equipment damage.*
Note	*Provides supplementary information to emphasize a point or procedure, or provides a tip for easier operation.*

1.3 Contact Information

Technical Assistance and Customer Service

BridgeWave distributors and resellers are authorized local service providers and are responsible for immediate Tier 1 customer support. If a problem cannot be resolved, contact BridgeWave Customer Service for assistance:

Location:	Santa Clara, CA USA
E-mail:	support@bridgewave.com
Tech Support Hot Line:	+1.408.567.6906
eService Center	http://bridgewave.com/support

Return Material Authorization (RMA)

Should BridgeWave equipment have to be returned for repair or replacement, an RMA number must be obtained in advance from BridgeWave or a local BridgeWave distributor. When returning equipment, be sure to clearly indicate the RMA number on the outside of the shipping carton.

BridgeWave eService Center:

You can view knowledgebase content, open a ticket, update tickets and request RMAs on-line 24x7. To view current ticket and RMA status, please go-to http://bridgewave.com/support and select 'eService Center' to login and enter your support portal.
First time users of eService Center will need to submit a request to Support@bridgewave.com, for a login ID and password.
A support engineer will contact you with your login ID and password.

BridgeWave Sales

E-mail:	sales@bridgewave.com
Inside Sales:	+1.866.577.6908

2 Site Planning

2.1 General

Before the start of any installation, a survey of the planned deployment site should be conducted first. The surveying personnel should be fully familiar with the details and requirements needed to successfully install the 80GHz radio system.

2.2 Equipment Checklist

We suggest the site survey team may need the following equipment:

- Binoculars (not always required)
- WAAS-capable GPS location device
- Tape measure to determine distances for cable runs to ingress points
- Digital camera (not always required)
- Site survey report form to document and help assess site
- Signaling mirror (provided but not always required)
- 70-90GHz Link Registration Datasheet. Contact BridgeWave Tech Support to learn where one can obtain the latest version of this form. You may E-mail support@bridgewave.com for this request or request it on-line via eService Center http://bridgewave.com/support.

2.3 Line of Sight (LOS)

The 80GHz Wireless Gigabit Ethernet link requires LOS for proper operation. Binoculars and spotting mirrors may be used to assist in the confirmation of LOS.
Path planning should include an investigation into future building plans that could block the LOS path, and other long-term incremental obstructions such as tree growth. Intermittent obstructions such as aircraft at a nearby airport should also be considered.

The following table details the minimum F1 (First Fresnel) clearance needed from obstacles in order to ensure the radios will operate properly.

Table 2.3-1: Minimum Path Clearance

Path Length (meters)	Minimum F1 Clearance (meters)	Path Length (miles)	Minimum F1 Clearance (feet)
1000	0.58	0.62	1.9
2000	0.82	1.24	2.7
5000	1.3	3.10	4.3
10000	1.8	6.21	5.9

2.4 Link Distance

Measurement of the link distance is important in estimating the link availability and calculating expected Receive Signal Level (RSL). This measurement can be performed using the Latitude and Longitude coordinate readings from a Global Positioning System (GPS) device, which is placed near the proposed locations of the antennas. Additionally GPS reading will be required in order to comply with the FCC registration process.

The Minimum 80GHz Link distances are as follows:

- AR/GE/FE-80: 328 feet (100 meters)
- AR/GE/FE-80X: 1312 feet (400 meters)

To estimate maximum distances and availabilities for a given product and region, BridgeWave's Path Availability calculator can be used. To obtain the latest version of BridgeWave's Path Availability calculator, contact BridgeWave's Customer Service or search eService Center Knowledgebase.

2.5 Antenna Location

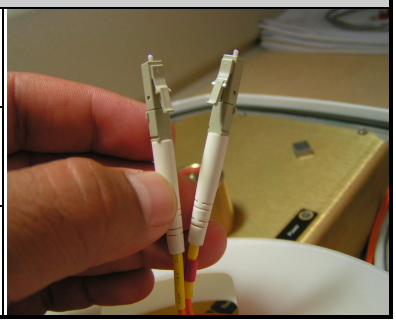
The optimum location for the antennas must be determined. The ideal location should provide for ease of erecting and mounting the antenna, as well as providing unimpeded LOS to the remote location. The following factors should be taken into account:

- Type of mounting—fixed or roof-safe pole mounting.
- Location of fiber and DC power wiring ingress/egress of the building.
- Length of cable runs.
- Confirmed Earth Grounding connection points.
- Obstructions, including allowances for tree growth.
- Accessibility of the radio mounting location.
- Accessibility of the site during and after working hours.

2.6 Cabling

The installation site should be inspected to determine the run paths for the fiber cable and power cable from the radio equipment to the termination point. Locations for roof penetration should be identified. The routing and securing of all cables should conform to all applicable codes and requirements. Depending on the likelihood of damage due to foot traffic or equipment movement, cabling conduit may be required. The maximum cable run length as specified for the equipment being installed must not be exceeded, refer to Table 2.6-1 and 2.6-2 for cable types and limitations. The radio requires LC type connectors on duplex multi-mode fibers to properly connect between the radio and the users network equipment. Single-mode fiber connections are not supported for use with the standard product. The network equipment end of the fibers should be terminated with connectors that match the user's network equipment fiber interface.

Table 2.6-1: Maximum Fiber Length

Fiber Cable Length	Cable Type	
Up to 270 meters	62.5/125 µm	
Up to 500 meters	50/125 µm	

The 80GHz radio includes a 100-240 VAC power adaptor, suitable for indoor operation only, that converts the AC voltage from a standard electrical outlet in the wall to DC voltage. For outdoor-rated power supply options, contact BridgeWave customer service. The radio requires a minimum of 15.0 VDC at the connector on the radio unit (24.0 VDC maximum) to function properly.

When planning the cable run from the indoor AC power adaptor to the radio unit, it is required to use the cable gauge (AWG) indicated below to ensure adequate voltage at the radio. The indoor and outdoor portions of the DC power cabling must conform to all respective indoor and outdoor national and local electrical and building codes; note that requirements may differ for the indoor and outdoor portions of the cabling and that a grounded surge protector is normally required at the point where the cable enters the building. The DC power cabling must consist of two 12 or 14 gauge-stranded conductors based on the required cable run length.

Table 2.6-2: Minimum DC Cable Size

DC Cable Length	Conductor Size
Up to 125 meters	14 AWG (2.5mm²)
Up to 200 meters	12 AWG (4mm²)

Figure 2.6-1 shows a standard 14-gauge wire that has been fitted with the power connectors (provided) for the radio's internal power supply necessary to mate with the (not provided) DC power

cables. A standard crimping/splicing tool (not provided) is required to terminate the power connectors onto a 14-12-gauge cable required for use with the 80GHz.
On the radio end no connectors are required; simply screw terminals to appropriate polarity. The DC power cable should be fed into the connector on the casing first and then the green connector attached to the radio after making a strain relief coil around the electronic housing.

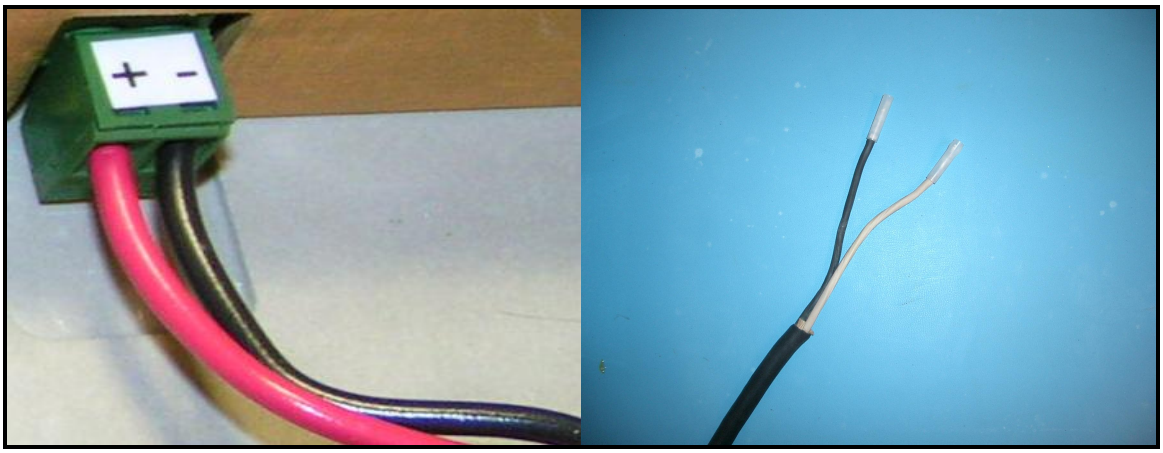


Figure 2.6-1: (Left) 14-gauge DC power cable terminated to radio end. (Right) DC 14-gauge cable from the power supply end.

2.7 Grounding & Lightning

Danger	*Proper grounding of the outdoor equipment reduces electromagnetic interference, provides lightning protection, and protects against electrical discharge.* *Using improper techniques in lightning prone geographic areas may pose a danger to local personnel.* *The source and connection points for the building-to-earth ground in the vicinity of the antenna location should be determined.*

In addition to grounding the equipment, **BridgeWave strongly recommends**, and local building codes may require, the DC electrical cable to be protected from electrical surges by a surge suppressor. The surge suppressor must be installed at the point where the DC electrical cables exit/enter the building.

Note	*For more information on recommended accessory devices and kits, contact BridgeWave Sales*

2.8 Environmental

The structure to which the equipment will be mounted should be adequate to bear all wind and weather conditions. The environmental conditions at the location must conform to the operating environment specified for the equipment.

2.9 Cabling Diagram

Figure 2.9-1 details the equipment and cabling found on a typical installation of BridgeWave's 80GHz radio equipment. Use of the copper port is optional and is not required for management agent access or for normal data traffic operation.

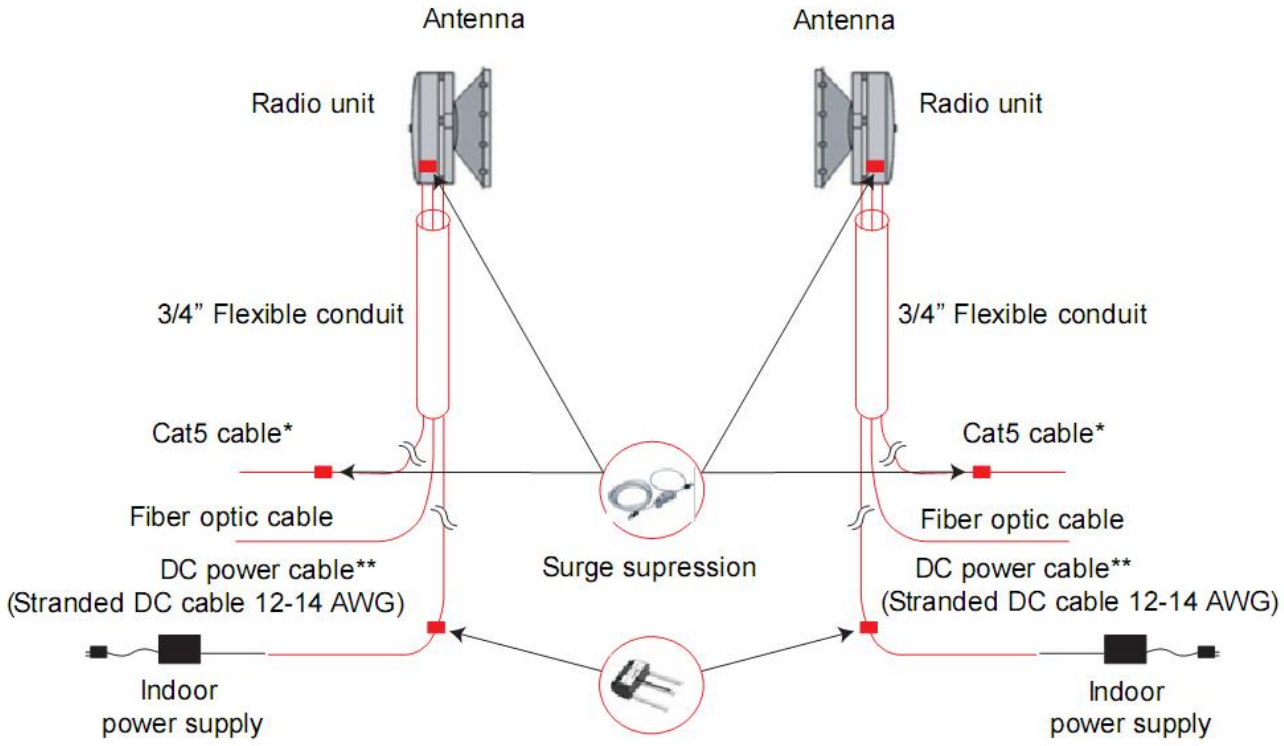


Figure 2.9-1: Simple Network Diagram

3 Installation

3.1 General

It is recommended that installation personnel read this section in its entirety prior to installing the BridgeWave System. During a particular phase of installation, the user may refer directly to the applicable subsection.

The Installation section is comprised of seven subsections covering the procedures and guidelines for installing the BridgeWave Radio System.

Subsections 3.3 through 3.4 contain information necessary to prepare for the equipment installation.

Subsections 3.5 through 3.8 covers equipment installation procedures.

Subsections 3.9 and 3.10 contain information necessary for aligning the antenna.

3.2 Equipment Unpacking

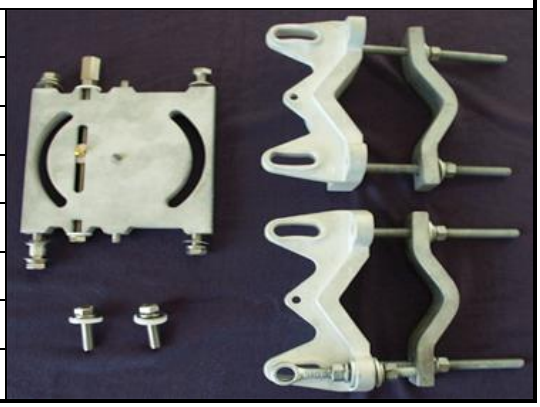
The radio system equipment will arrive in two boxes—one box for the low band radio and one box for the high band radio. Locate the correct box (low band or high band) before beginning installation by checking the label on the outside of the box or on the radio itself. It is recommended that the shipping cartons and packing materials be retained in the event that it is necessary to return any equipment.

Note	*The radiated polarity can be identified on unpacked radios by the first letter of the polarity V or H (Vertical or Horizontal) on the top of the unit chassis or by the polarization labels. See Figure 3.6-1 and 3.6-2 for further details.*

3.3 Equipment Inventory

Following are inventory lists for a typical system:

Table 3.3-1: Radio and Electronics Parts List	
Qty	Description
2 ea.	80GHz radio unit (1 low-band transmit unit & 1 high-band transmit unit)
2 ea.	Standard Power Supply (Indoor rated, 100-240VAC input to 24VDC output)
1 ea.	CD with Manuals (1 CD provided per pair of radios)
2 ea.	DC power connection set. (Includes 2-prong DC plug and 2 ea slip fit plugs/receptacles)
2 ea	Antenna and mount kit
1 ea.	Signaling mirror
1 ea.	Hard reset box
2 ea.	RSL / Quality test cable
2 ea.	Stainless Steel Screws # 8-32 X 3/8, Phillips pan head

Table 3.3-2: Antenna and Mount Kit Parts List		
Qty.	Description	
1 ea.	Antenna	
1 ea.	Lower pole mount assembly	
1 ea.	Upper pole mount assembly	
1 ea.	Antenna mounting plate	
2 ea.	3/8 bolts	
2 ea.	3/8 lock washers	
2 ea.	3/8 flat washer	
2 ea.	3/8 nylon washer	

Note	*For more information on recommended accessory devices and spare parts, contact BridgeWave Sales*

Warning	*The radio is sealed at the factory warranty stickers on the inner (metal) cover of the radio. There is no need to open this cover in the field. Tampering with these seals will void the warranty.*

3.4 Installation Tools

The following tools, not provided by BridgeWave, are required for installing the radio and the antenna:

- Screwdriver, slotted 0.1 inch wide.
- Open-end wrench 9/16 inch - 2 ea.
- Open-end wrench 1/2 inch.
- Ratchet with 6-inch extension and 9/16 inch deep socket.
- Wire stripper/cutter/crimp tool (10-16 gauge).
- Electrical tape.
- Fish tape for pulling cable.
- Cable tie wraps.
- Hand-held DVM (digital voltmeter) with standard banana plug receptacles.

3.5 Antenna Mount Installation

Warning	*1. Read these instructions before beginning installation. Caution should be used. Qualified persons experienced with antenna assembly and installation are required for installation.* *2. BridgeWave Communications Inc. disclaims any responsibility or liability for damage or injury resulting from incorrect or unsafe installation practices.* *3. The antenna has been formed to a very close tolerance parabolic shape. Careful handling and assembly is required to avoid denting the reflector, which would degrade antenna performance.*

Warning	*When using the left side radio mount position, the antenna ends up getting rotated by 180 degrees.* ***The drain hole must be open at the bottom and closed off at the top of the antenna to prevent water ingress.*** • *For the 80X, move the bottom drain hole plug to the top drain hole position.* • *For the Standard 80 remove the four Philips head screws*

	from the radome and rotate the radome so the drain hole is at the bottom. Be careful not to contaminate, damage or smudge the shiny coating of the antenna surface or feedhorn and make sure the gasket is evenly seated when re-attaching the radome cover.

1. Attach the upper pole mount to the antenna mounting plate.

   Confirm that the mount is centered as shown.

   Tighten bolts securely.

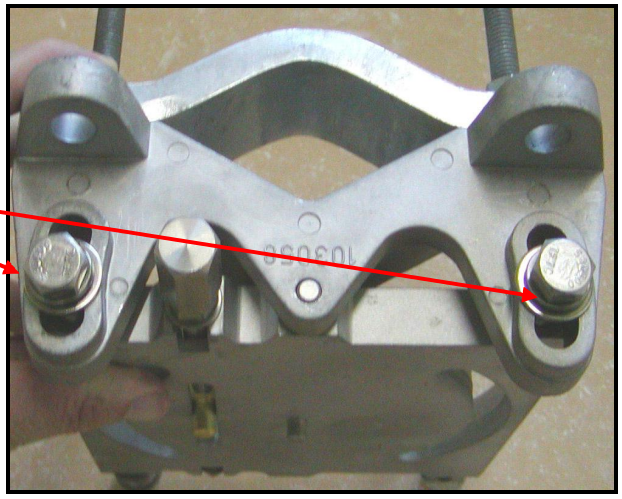


Figure 3.5-1: Upper pole mount attached to antenna mounting plate

2. Attach the lower pole mount and azimuth fine adjust as shown.

   Hardware: Flat washer, bushing (inside eye), flat washer, lock washer, bolt.

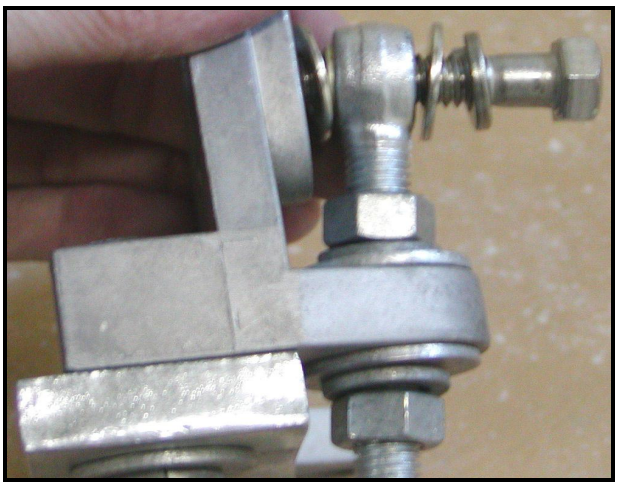


Figure 3.5-2: Azimuth fine adjust assembly

Confirm that the mount is centered as shown.

Tighten bolts securly.

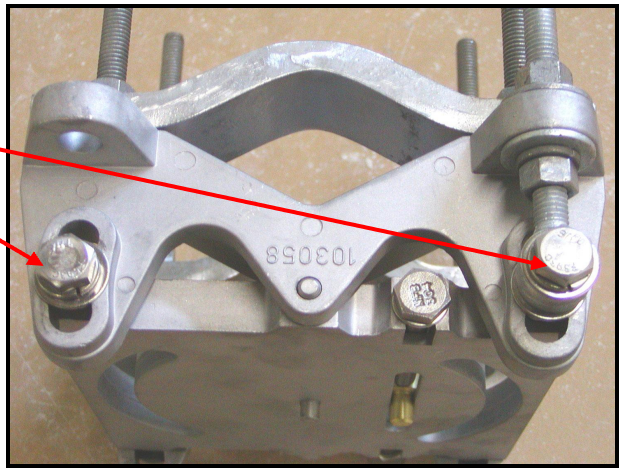


Figure 3.5-3: Lower pole mount attached to antenna mounting plate

3. Completed installation of pole mount with right hand offset for the antenna.

   Note the position of the elevation fine adjust hex nut.

   The pole mast (not supplied) must be 3.5 to 4.5 inch (89 to 114mm) O.D. SCH40 steel pipe or equivalent.

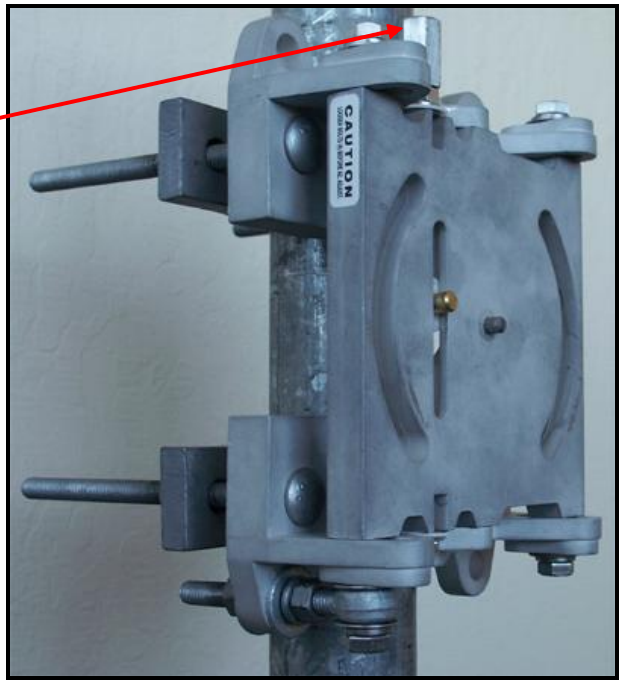


Figure 3.5-4: Pole mount with right hand offset

1. Optional left hand antenna offset mount preparation:
   - Remove azimuth bolts
   - Rotate the antenna mounting plate 180º
   - Replace azimuth bolts
   - Tighten azimuth bolts

   Note the position of the elevation fine adjust hex nut.

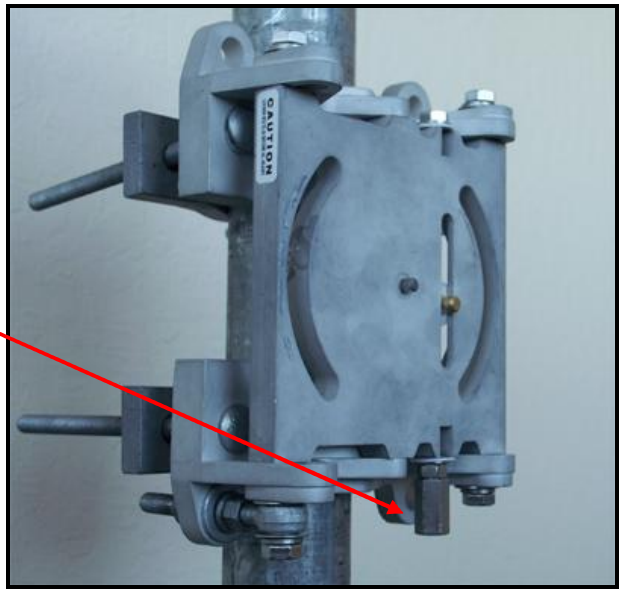


Figure 3.5-5: Pole mount with optional left hand offset

3.6 Antenna and Radio Installation

Warning	*It is critically important during installation to ensure the radios on each side of the link are in the same polarization (horizontal-horizontal or vertical-vertical). A link that has a radio on one side of the link set in the horizontal polarization and the other side of the link set in the vertical polarization will not operate properly.* *It is also critically important that a high-band radio is paired with a low-band radio to ensure the system will operate properly. Prior to installation check each radio to verify one is a high-band and the other is a low-band version. The label on the radio will indicate the band (blue for high or red for low).*

1. Install antenna and radio:

   The first letter of the designated polarization is stamped onto each unit to identify orientations when the polarity mark is positioned on top:

   "H" for horizontal.

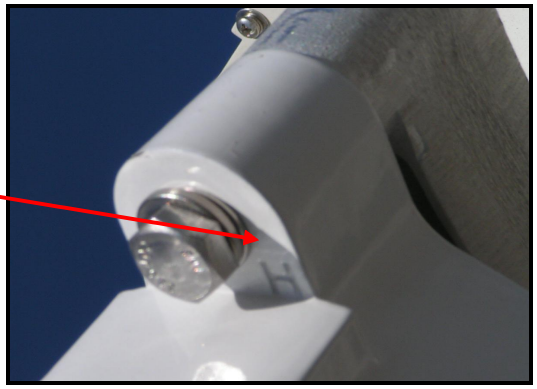


Figure 3.6-1: 80GHz Unit mounted in horizontal polarity

2. Verify that the four (4) captive 3/8-16 bolts with lock and flat washer are in place.

   It is important that all four bolts are tightened evenly (hand tight, 1 to 2 turns each until the lock washer is flattened).

   Units have captive bolts attached to the radio housing. A 9/16-inch open-end wrench is required to tighten them.

   Units have captive bolts attached to the 2' antenna. A 1/2-inch open-end wrench is required to tighten them.

   "V" for vertical polarity.

Figure 3.6-2: 80GHz Unit mounted in vertical polarity

3. Course align azimuth (i.e. side-to-side or horizontal) and tighten 4 carriage bolts to secure pole mounts.

4. Loosen the 4 azimuth lock bolts.

5. Adjust eyebolt length using a 9/16" open-end wrench to required location.

6. Secure the 4 azimuth lock bolts (tighten untl lock washers are flattend).

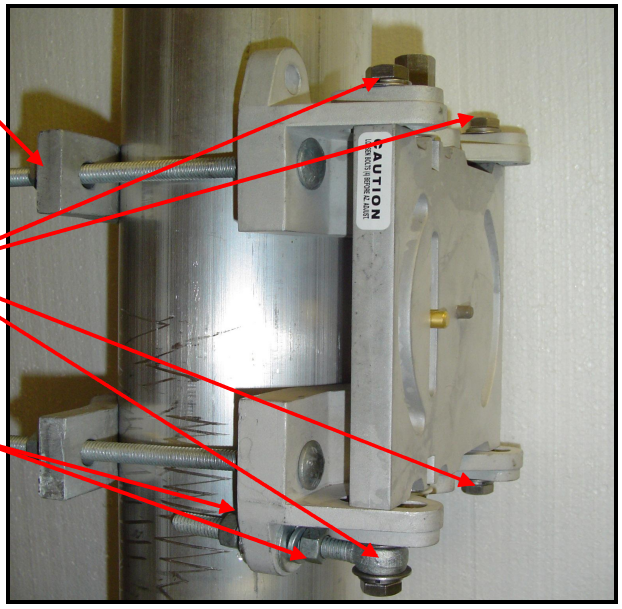


Figure 3.6-3: Azimuth adjustment bolts
(Note: Antenna not shown for clarity)

Warning It is very important that the azimuth bolts are tightened before any elevation adjustment is attempted. The very narrow beam width of these antennas (0.4º and 0.9º) makes it necessary to completely tighten the bolts of the azimuth adjustment while adjusting the elevation and vice versa.

7. Loosen the 2 antenna mounting bolts

8. Rotate elevation fine adjust hex nut as required to set correct elevation (i.e. up-down or vertical).

Warning Do not try to adjust the elevation fine adjust bolt without first loosening the antenna bolts (step 7). Doing so may damage the brass elevation adjustment pin.

9. Tighten the 2 antenna mounting bolts after correct elevation is set.

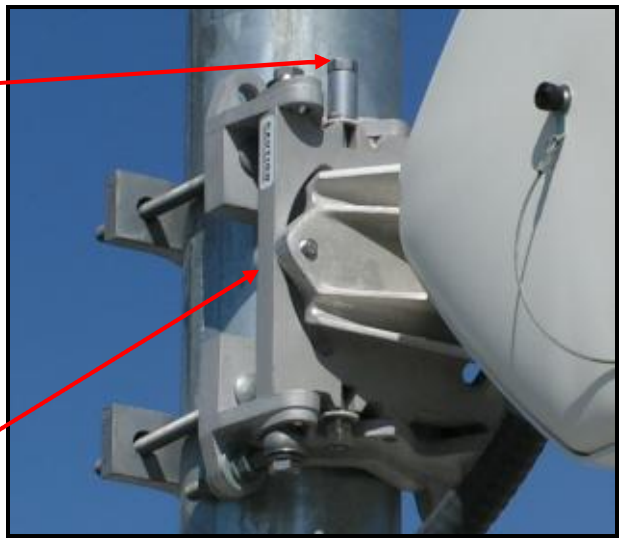


Figure 3.6-4: Elevation fine adjustment

3.7 Cable Installation

3.7.1 Fiber Cabling

1. Install a duplex multi-mode fiber from the radio to the network termination equipment (switch or router with 1000Base-X port). The cable should be looped around the inside of the enclosure to provide strain-relief. Do not connect the fibers to the radio's fiber ports at this time.

   The connectors on the radio end of the fiber require two LC connectors; the connectors on the switch/router end should mate to the network equipment.

2. Connect fibers at the network equipment.

Warning	*It is important not to connect the fibers to the radio until after aligning the radio as the radio performs an automatic calibration once the fiber is inserted into the radio and this calibration will not operate properly if the radio is not properly aligned. If this inadvertently occurs while the radio is powered on, unplug the fibers and power cycle the radio.*

3.7.2 Power Cabling

1. Select indoor location, with easy cable routing to the radio, for the AC power adaptor. Normally it is convenient, but not required, to place the adaptor near the network termination equipment.

2. Ensure the DC wire used is 14-gauge type and no longer than 125 meters; or 12-gauge and no longer then 200 meters.

3. Connect the provided DC Connectors onto the 14-guage wire using a splicing/crimping tool. For the use of 12-gauge wire it may be necessary to trim a few strands from the ends of thicker stranded cables to more easily fit the crimp connectors.

4. Install the DC power cable and attach to the AC adaptor using the supplied crimp connectors. Do not connect the power jack to the radio at this time.

Note	*The fiber and power cables are inserted through the straight through fitting before the 3/4" flexible conduit is connected to the fitting. Ensure that the cables do not get pinched when the conduit is pushed onto the fitting. Both cables should be looped around the inside of the enclosure to minimize tension on the cables when connected to the radio and to maintain proper bend-radius of the fiber cable. See Figure 3.7.2-1*

Note	*A -48Volt DC version is available for this product. The power connector is the same but the connector location is slightly moved. The NMS 'Status Page' reading will still read 24V.*

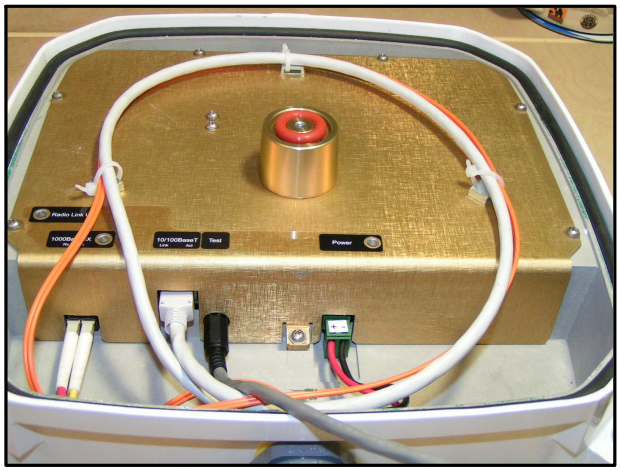


Figure 3.7.2-1: 80GHz power and data cables with service loop for strain relief and proper fiber bend radius.

3.7.3 Ground Cabling

The preferred method for grounding the radio unit is to ground the mast to a ground source, since this provides the largest grounding surface contact possible. If this is not possible, then use the following procedure:

1. Attach the lug of the ground cable (not provided) with the radio to one of the two #8 holes at the bottom of the radio using a #8-32 x ½" long bolt, #8 lock washer and #8 flat washers (not provided).

2. Connect other end of the ground cable to a nearby ground location.

3.7.4 10/100Base-T Surge Suppressor

If the 10/100Base-T port is permanently connected to other network equipment (not normally required), it should be connected using Cat5e UTP cables rated for the outdoor and/or indoor environments where the cables will be run.
It is essential that the cabling be connected to the radio unit through an Ethernet-rated surge suppressor inside of the plastic back cover of the unit, and a surge suppressor should also be used at the point where the cable enters a building or is connected to other outdoor equipment that does not already contain surge suppression hardware.

Note	*For more information on recommended accessory devices and kits, contact BridgeWave Sales*

Warning	*Failure to install surge suppression hardware on the UTP cable inside the radio and a second surge suppressor at the building's point-of-entry can expose the radio and network equipment to electrical surges due to lightning strike or other phenomena. Such electrical surges could cause irreparable damage to the radio and/or network equipment not covered by the manufacturer's warranty.*

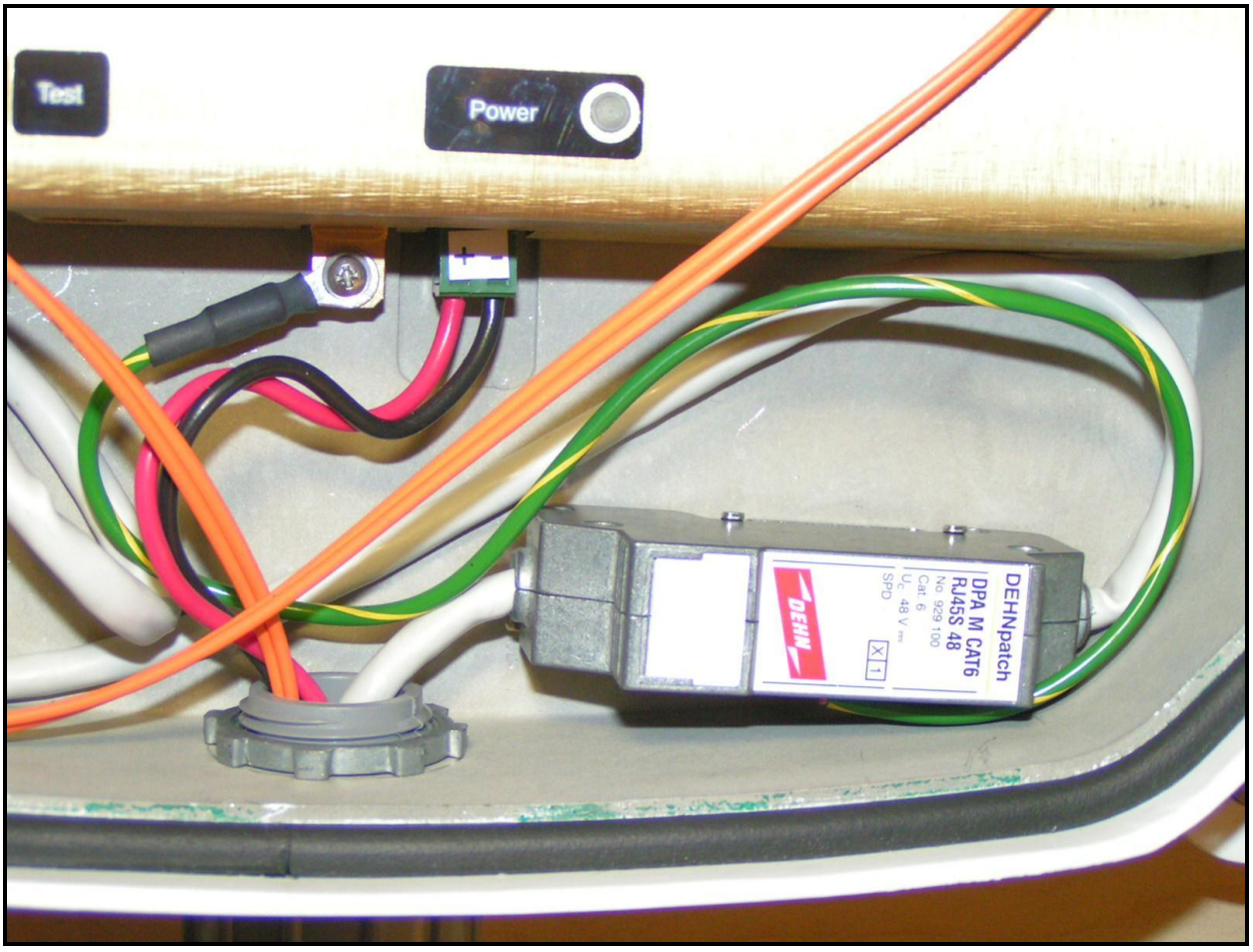
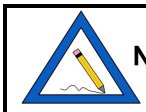


Figure 3.7.4-1: Ethernet surge suppressor connected to radio 10/100Base-T port

3.8 Ice Shield Canopy Installation

 **Note**	*The Ice Shield assembly is an optional item and can be ordered in kit form through a BridgeWave sales or distribution partner.*

3.8.1 Introduction

In northern climates, the buildup of ice or snow on antennas can be a problem for millimeter wave radio installations. These problems are twofold: the electrical effect of snow and ice built up on the antenna's radome; and the mechanical impact of the additional weight of the snow or ice on the antenna and supporting structure.

The formation of ice or snow on the antennas radome can cause attenuation of the signal to the point where the link may become severely degraded or unusable. Uneven ice buildup can cause scattering of the signal, which in turn results in standing waves.

At 80GHz, ice buildup less than 1mm thick (one-quarter wavelength at 80GHz) may result in degraded performance of the link. Such thin layers are not likely to exist for extended periods, as ice tends to melt. In cold climates when the radome is below freezing temperature, ice does not stick to it, thus there is no issue. However in mixed rain-snow-ice storms, ice can stick to the radome, causing the link to operate at less than its optimal design.

Once the ice has hardened and freezes, the added weight of the ice on the antenna increases the wind load on the tower or mast, which may cause premature failure of the mounting structure. As ice breaks apart due to melting, or via its own weight, these large and heavy sheets falling down a tower or mast can cause damage to antennas or other objects mounted below.

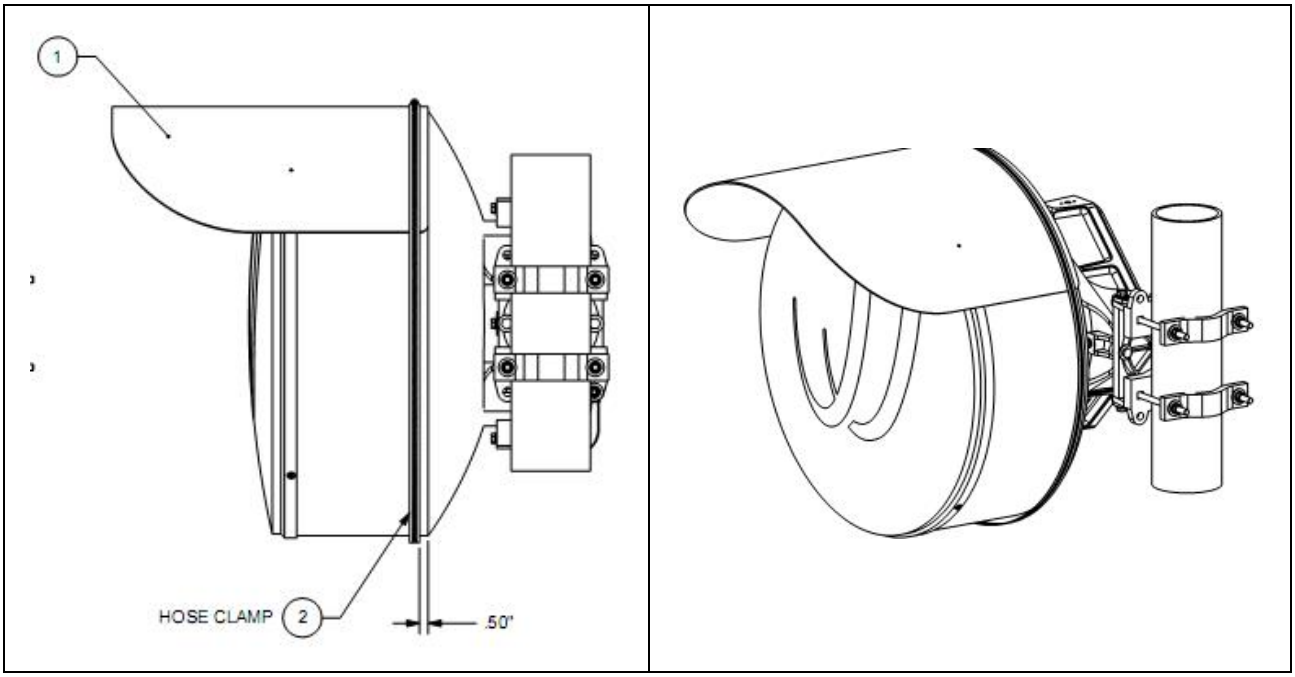


Figure 3.8.1-1: 80X Ice Shield

BridgeWave provides an ice shield kit, designed to combat the buildup of ice on BridgeWave's 80GHz wireless bridges.

These inexpensive ice shields are designed to be easily fitted on radios with integrated antennas or radios with 24" antennas.

3.8.2 Optional Kit

The part number for this kit is 515-00529 (Available through Sales, see Contact Info section)

Refer to the table below for the kit required for your particular application.

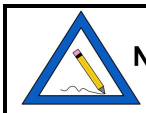
Each kit contains the necessary materials for the installation of the ice shield on one radio.

Two kits are required per link.

Qty:	Description:
1 ea.	Ice Shield Canopy
1 ea.	Ice Shield Clamp, 6'

3.8.3 Installation Instructions

1. Remove the protective liner from the plastic canopy
2. Use a screwdriver or 5/16” nut driver to set the hose clamp to the end of its range for maximum opening
3. Slip the hose clamp over the radome so that it loosely sits in approximately the middle of the radome.
4. Slide one end of the plastic canopy under the clamp and slowly bend it around the canopy and work it under the rest of the clamp.
5. Align the canopy to the back edge of the radome and position the clamp 1 to 3” away from the edge
6. Tighten the clamp until snug. (*Do Not Overtighten*)

 **Note**	*Remove canopy when it’s not snowing to reduce antenna wind loading*

3.9 Antenna Alignment

3.9.1 Before Turning On the System

1. Finish the installation as described in Chapter 3.5 and 3.6
2. Ensure fiber cables are still disconnected!

3.9.2 Connect DC power to the radio.

3. Verify that the Power LED is lit. If the Power LED is not lit, carefully use the voltmeter to verify the correct voltage and polarity at the radio connector. Turn off the Power Supply before making any corrections.
4. Repeat steps 1 through 3 on the far-end of the link.

3.9.3 Prepare to rough align the radio.

5. Connect RSL test lead cable to radio and place voltmeter with readings in view.
6. Loosen the pole mount brackets enough to allow you to swing the unit horizontally.
7. Reference Chapter 3.5 for illustration of antenna mount bolts and their purpose.

3.9.4 Rough align the radio antennas

8. Set the radio terminal to the pre-defined azimuth if available. If not, you may utilize binoculars or signal mirror to locate the far end radio location.
9. If you can see the far-end radio terminal estimate the alignment visually and tighten the pole mount brackets with fine adjustment bolt set to the middle of adjustment range.
10. Ensure the horizontal adjustment bolts are snug; only tighten bolts one quarter of a turn.
11. Slightly rotate each antenna up/down for best vertical alignment and left/right for best horizontal alignment by finding the maximum RSL voltage reading.
12. To ensure that the antennas are not aligned on a side-lobe, they must be rotated at least ten degrees on each side of the visually-perceived alignment center to ensure that the true maximum RSL voltage is found.

Note	*The width of the center beam is only 0.4° (80X) or 0.9° (80) and the first side-lobe beam is only 1 degree off from center.*

Set the antenna in the position that results in the highest RSL voltage reading.

13. Repeat these steps on far end radio.

3.9.5 Fine Adjustment

14. Ensure to loosen the "fine adjustment" bolt (the small eye bolt).
15. Pan antenna slowly from left to right and capture the highest RSL voltage peak.
16. See Figure 3.9.5-1 below to help guide you in obtaining the highest RSL voltage reading.
17. Tighten down the azimuth adjustment bolts.
18. Loosen the two bolts holding the antenna to the antenna mount.
19. The vertical fine adjustment bolt is not designed to be tightened; use the "hex nut" to fine (and course) adjust the elevation (vertical position) to highest RSL value.
20. While monitoring the voltmeter, begin to align the vertical position of the antenna to obtain the highest RSL voltage level.
21. Once completed, this fine adjustment must be repeated at the remote end of the system, if you have not obtained the "target" RSL voltage for the given path distance (see RSL Vs. distance chart in Appendix B).
22. If you have not obtained the "target" RSL voltage for the given path distance (or you want to further improve it), you will need to re-align the antenna, go back to the original site you started with and restart steps 14-21 and re-align again. See Figure 3.9.5-1 below of a conceptual illustration of the antenna beam to keep in mind while you perform a re-alignment.
23. Once again, the very narrow beam width of these antennas (0.4º and 0.9º) makes it necessary to completely tighten the bolts of the azimuth adjustment while adjusting the elevation and vice versa.

Note	*Verify that the RSL voltage falls within the expected range based on the graph in Appendix B.*

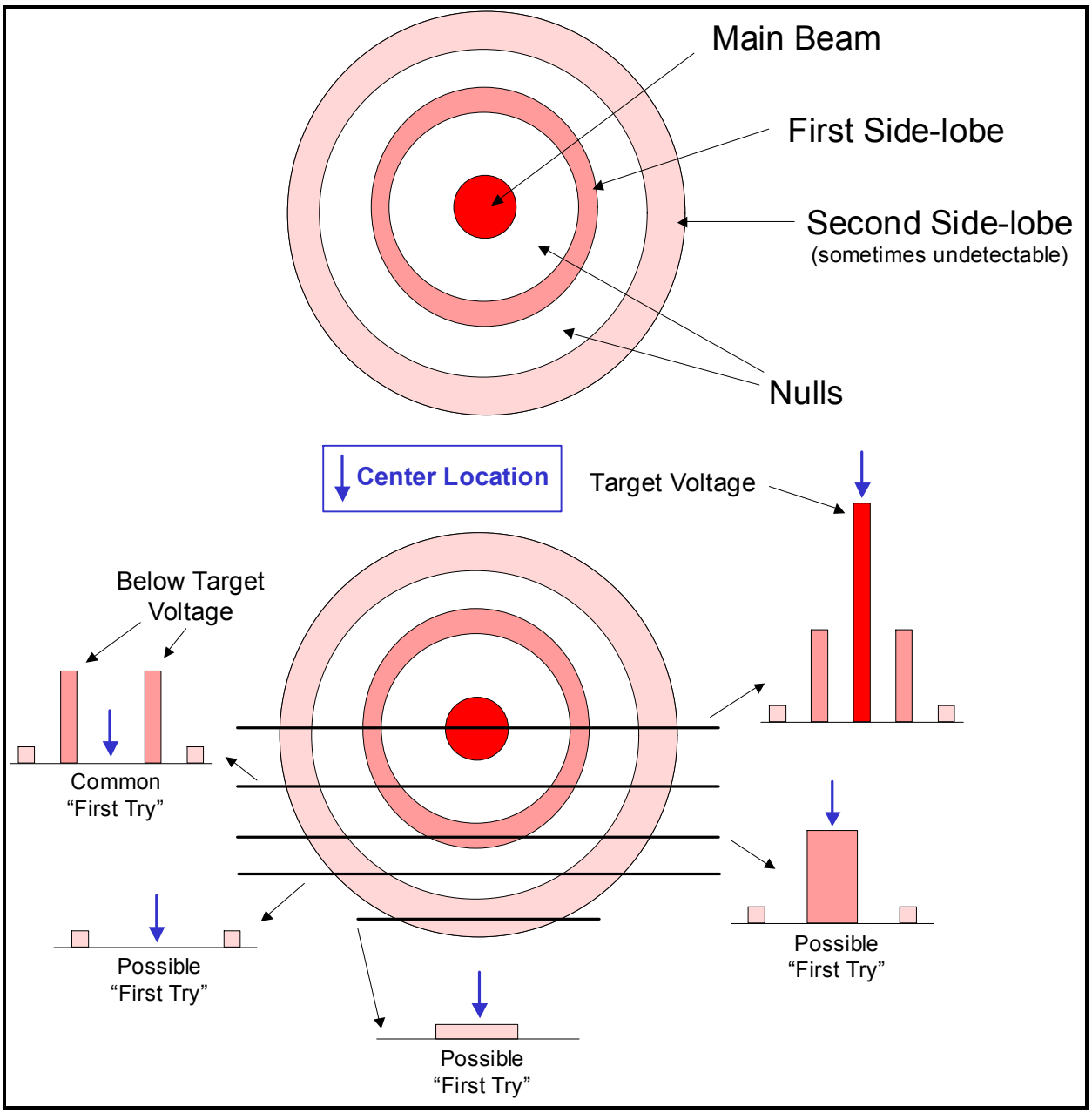


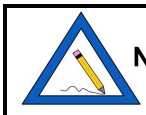
Figure 3.9.5-1: **This illustration is a conceptualized cross section of a beam to exemplify a horizontal RSL level voltage reading against relative locations with an assumed fine tuned vertical position. Keep in mind how narrow the beam is at 80GHz, the 3dB beam width for 80GHz is 0.9º with 12" antenna and 0.4º for 24" antennas with the extended range models 80X.**

3.9.6 Locking Down Radio Antenna

24. After the target RSL level has been achieved, ensure all bolts are tightened evenly, securely and ensure the RSL voltage remains unchanged after tightening is completed.
25. The very narrow beam width of this antenna (0.4º and 0.9º) makes it necessary to completely tighten the bolts of the azimuth adjustment while adjusting the elevation and vice versa.
26. Always evenly tighten bolts in small fractions at a time to ensure minimum change to your completed alignment.

3.9.7 Connecting the Fiber

Connect the fiber cable to one of the radios at a time. The fibers should already be connected to active network equipment.

 **Note**	*The fiber integrity indication on the network equipment could show up or down independent of the RF link status.*

3.9.8 Auto Calibration

27. Once the fiber is connected to the radio, the radio will begin an internal link calibration.
28. During this time the Link Up LED will blink for up to 120 seconds.
29. Wait until the Link Up LED is lit solid
30. Verify the Link Quality voltage is 3.0-3.3V (i.e., error free). Repeat steps (30-32) for the far-end radio. For more details on Auto Calibration see section 3-9 below

3.9.9 Remove the Test Cable

31. Remove the test cable from the radio, replace the rear plastic cover and hand tighten the back cover nut to the point where the back cover stops (i.e. when it hits the metal ring on the back metal plate). The installation is now complete.

Note	*The most important alignment 'tool' for these models is care and patience! It is recommended that these models be aligned with personnel present at both ends of the link, and the installers should allow 90 minutes to optimally align these units.*

80 and 80X antennas exhibit narrow beam widths of 0.9º and 0.4º. Link distances are great and alignment becomes more critical.

3.10 Auto Calibration

The Auto Calibration feature scans the receive signal across the entire (broad) band and flattens the levels, much like the equalizer on your home or car stereo.

The radio system is said to be in “Alignment Mode” when it is first powered up with no fiber connected.

The Auto Calibration mode is triggered ON as soon as the fiber cable is connected. The fiber interface of the radio terminal needs to detect an optical signal of the appropriate wavelength. This requires the fiber optic cables be connected to a 1000Base-X port on an Ethernet device (switch, router, media converter, etc.) or this can be accomplished with a fiber optic loopback cable by connecting the fiber output of the radio into the fiber input of the radio.

If used, the loopback cable should only be connected long enough for auto-calibration to start and should be removed immediately.

The radio terminal indicates the Auto Calibration by flashing the Link LED on/off - this cycle lasts for up to 120 seconds.

Auto-calibration is a required step per installation once antenna alignment is completed.

3.10.1 AdaptRate™ Fiber Calibration Procedure (AR80 and AR80X only)

In order for an Adaptive Rate link to operate correctly, it is especially critical to ensure the following process is followed exactly. If you feel this process may not have been followed or you wish to re-attempt the process, be sure to first power down both radios, remove any fiber connection before turning the system on. This will get you back to original factory radio calibration settings and place the radio link in “alignment mode”.

START:

1. First, with a local PC, view each radio's Setup page and make sure the operating mode is set to AR and that the Installation Auto Calibration is 'enabled' at both ends. The default value is ‘enabled’.

   VERIFICATION: Double check this setting on both radios.

2. On initial Power up, do not connect any fiber cables

   VERIFICATION: It is best to physically disconnect any fiber cables from the radio unit ports, rather than just relying on the far ends of the cables being disconnected.

3. Upon completing the antenna alignment procedure, make sure both ends have a minimum of 2VDC in Quality voltage, if not, further alignment may be required. Small fluctuations are okay.

Warning	*If you do not obtain a Quality voltage of 2VDC, do not proceed to calibrate the system. Ensure you are aligned and achieve your target RSL level. This can be confirmed for your path distance by looking up the RSL voltage to distance curve in Appendix B.*

4. At this point you need to connect the fiber cable (or a fiber loopback if no network gear is terminated to the far end of the fiber).

If using a fiber loopback, remove immediately when the Link LED starts blinking.

Calibrate one side at a time and while monitoring the Quality voltage with DVM. Verify you are getting a 'quadruple hump'. i.e. voltage will rise, drop, rise, drop, and rise again, as illustrated below. It should end with a 3.0VDC to 3.3VDC reading on your DVM. Also verify the radio 'Link LED' is also 'flashing' on/off during this process. See Figure 3.10.1-1 for an illustration of the Quality Voltage as it fluctuates during the calibration process.

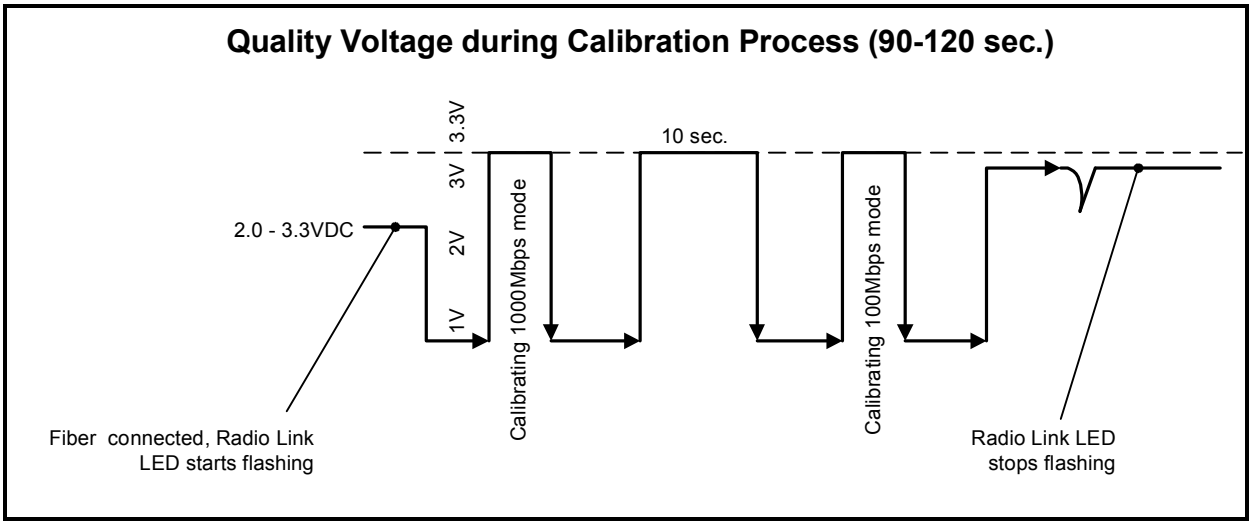


Figure 3.10.1-1: Quality Voltage reading during Auto Calibration process

If you cannot obtain a good quality voltage and you have obtained the target RSL, contact Technical Support at (408) 567-6906 or e-mail support@bridgewave.com for further assistance.

Warning	*You must wait for the Auto Calibration process to complete on one radio terminal before auto calibrating the remote radio and ensure both radios pass the calibration process. Failure to wait for the calibration to complete may result in a failure to create an RF connection between radio terminals.*

At this point, open the Status page from the unit's NMS interface and ensure the Radio TX and RX is operating at 1000 Mbps for both radios.

Note	*Click the refresh button a few times to ensure it is a good reading. If all indicators are good, then go to the next steps. If not, then go back to step 1 or contact BridgeWave Technical Support for assistance.*

5. Go to Statistics page and reset the stats for each radio end.

6. Perform a ping test. Open two command line windows and ping the local and remote management agent. Factory default IPs are; 192.168.0.1 for low-band and 192.168.0.2 for high-band and perform a ping to both ends and wait a few minutes, ensure you are getting responses from the local and remote management agents.

7. Review statistics page results and ensure packets are being transmitted, received, and there are no excessive error conditions.

8. If all is performing well, you must now 'disable' the Installation-Auto Calibration option on the Setup page of each radio.

3.10.2 Installation Auto-Calibration Feature (AdaptRate™ models only):

This feature should be disabled only after the radio system has been completely installed and calibrated as described above.
In the NMS 'Setup' screen, select Installation Auto-Calibration to 'Disable' and press the 'Submit new Values button at the bottom of the screen

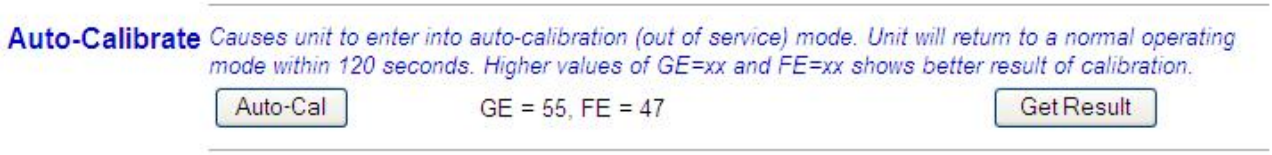
Figure 3.10.2-1: Installation Auto-Calibration Setting

(AUTO CALIBRATION FINISHED)

Warning	*Failure to 'Disable' the Installation Auto-Calibration option can trigger an inadvertent re-calibration of the system, under certain power failure conditions.*

3.10.3 Forced Re-Calibration

Option 1: Use the Auto-Cal function in the NMS 'Maintenance screen. This function will store the calibration values in non-volatile memory.


Auto-Calibrate
Causes unit to enter into auto-calibration (out of service) mode. Unit will return to a normal operating mode within 120 seconds. Higher values of GE=xx and FE=xx shows better result of calibration.
Auto-Cal
GE = 55, FE = 47
Get Result

Option 2: Enable "installation auto calibration" in the NMS and 'Apply Settings'. Disconnect the DC power and fiber optic cables from the radio. Power up the radio while the fiber is still disconnected. The Auto Calibration will start as soon as the fiber optic cable is reconnected to the radio terminal.

When a radio is power cycled with the fiber connected to network equipment, the radio will use the calibration values stored in non-volatile memory from the last successful auto-calibration process even if the enable Auto-Cal setting being set to 'Enable'. The radio link will come up immediately.

When a radio has "Installation Auto Calibration" disabled, the radio will use the calibration values stored in non-volatile memory from the last successful auto-calibration process, regardless of the fiber interface connected to network equipment or not.

Note	*Should moving the link to a new location or re-alignment of the link become necessary, the link must be recalibrated per the auto-calibration procedure described in Section 3.10.*

3.11 QUAL & RSL Test Cable

The alignment procedure is optimized through the use of the provided test cable. This test cable is designed for use with a digital voltmeter (not provided) to read the Link Quality and Receive Signal Level (RSL) voltage generated by the radio's receiver. See Figure 3.11-1.

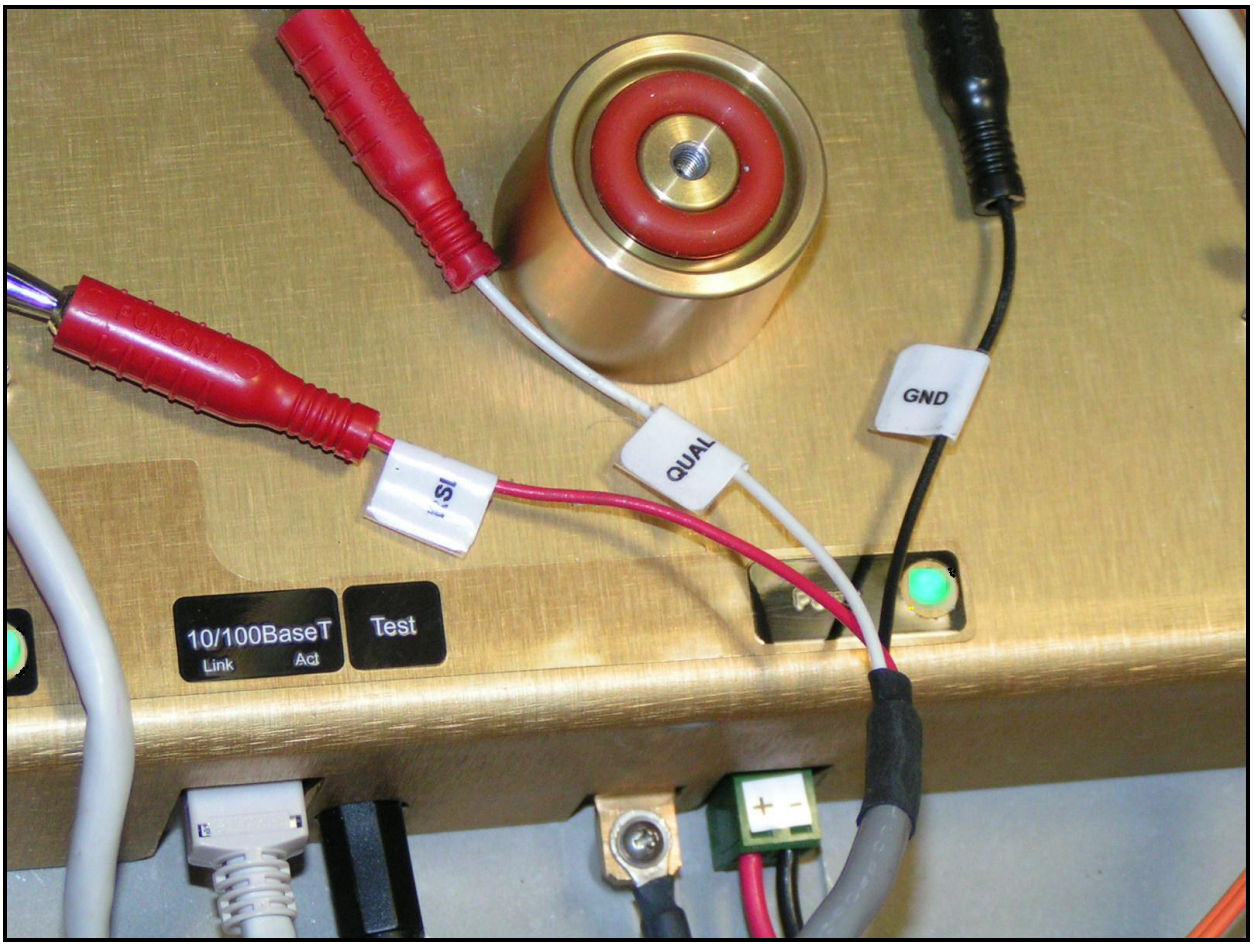


Figure 3.11-1: Supplied test cable for measuring Link Quality and Receive Signal Level voltages

1. To read the RSL value of the radio, insert GND (ground) and RSL banana plugs into the voltmeter. Note the RSL voltage. The voltage may be fluctuating; in this case, note the maximum value seen.

2. To read the Link Quality value of the radio, insert GND (ground) and QUAL banana plugs into the voltmeter. Note the Link Quality voltage. After the radios have performed an auto calibration the quality voltage should read 3.0-3.3VDC if the link is aligned on the main antenna beam and there are no obstructions (i.e., trees, buildings, etc…) in the path, the link distance is within the operating parameters of the radio (see Section 2.4 above), and it is not raining heavily.

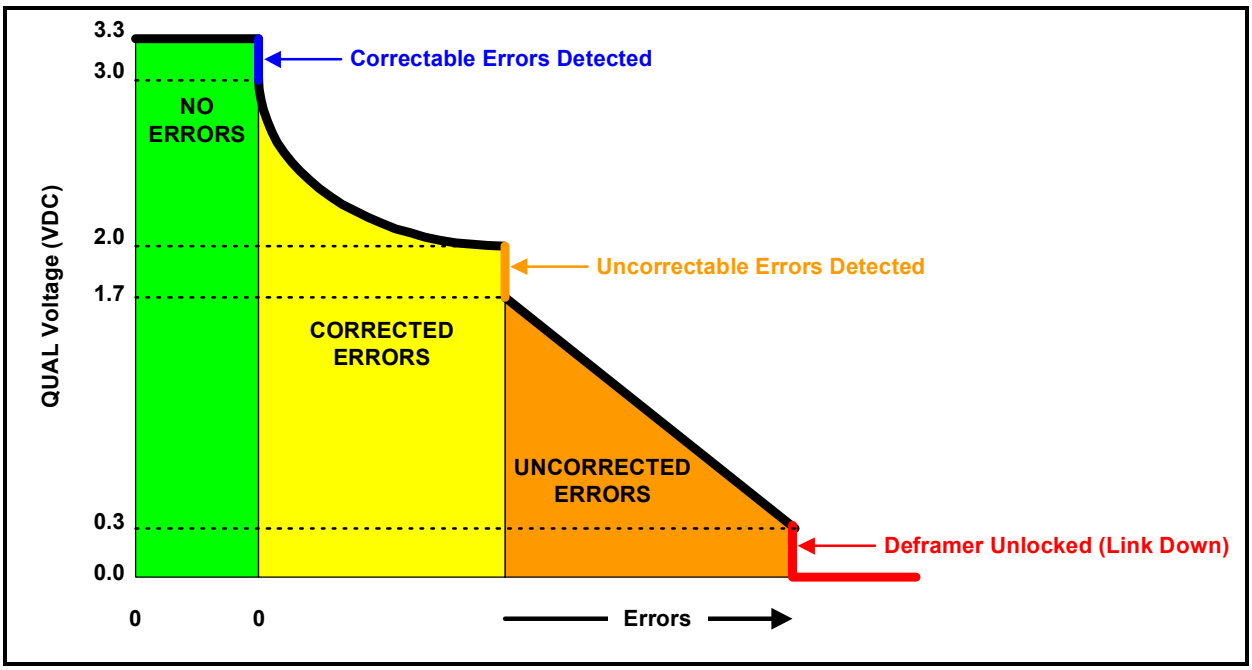


Figure 3.10.3-2: Quality Voltage Graph

- Quality Voltages between 3.0V and 3.3V indicate PRE and POST FEC error-free wireless link.
- Quality Voltages between 2.0V and 3.0V indicate a low rate of errors that the forward error correction will correct. The lower the voltage, the more errors are being corrected.
- Quality Voltages between 0.3V and 1.7V indicate excessive PRE-FEC errors in the wireless link, some of which cannot be corrected by the FEC. To indicate this change in error performance, the quality voltage will drop from 2.0V to 1.7V in a single step.
- Quality Voltages below 0.3V indicate an unlocked deframer condition. This will be recognized as a link-down condition.

4 Radio Link Status Indicators

During normal operation, the following conditions should exist at the radio, as shown in Figure 4-1:

- The Power LED should be lit—solid green;
- The 1000Base-X (Fiber) LED should be lit—solid green;
- The Radio Link Up LED should be lit—solid green;
- The Link Quality BER voltage normally should be 3.0-3.3v when it is not raining.

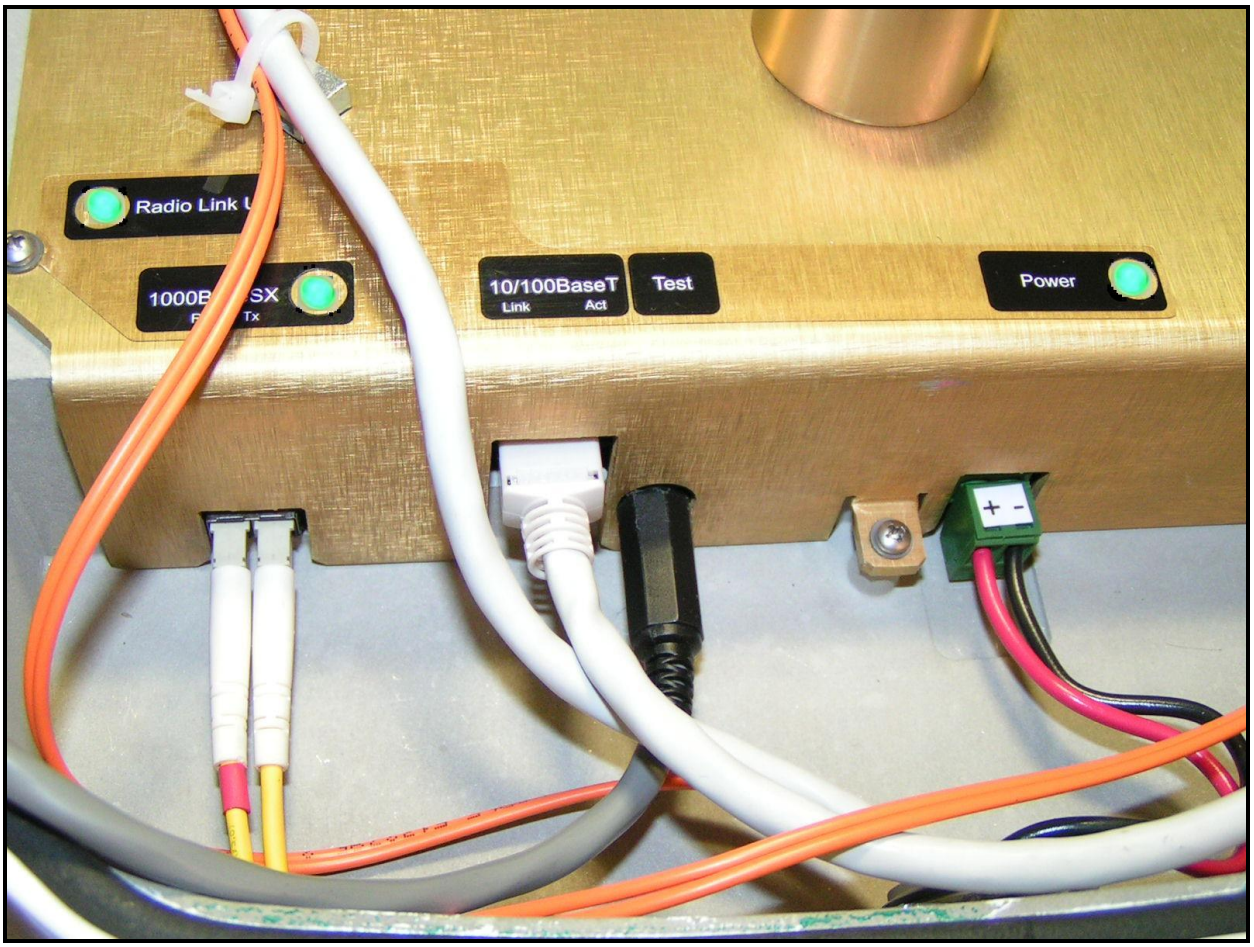


Figure 4-1: LED's indicating power, RF link is up and operational, and fiber connected to network equipment

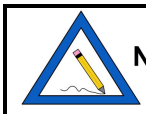
The 80GHz system does not require periodic maintenance. However, each end of the link should be periodically inspected for visible damage or excessive accumulation of dirt on the antenna's radome.

5 Connecting Network Equipment

The networking equipment that will be connected to the 80GHz System should be pre-checked to ensure it operates properly back-to-back over a wired connection. Once this has been confirmed, it will save troubleshooting steps if a traffic problem arises after the radio is installed and connected to the network equipment.

The 1000Base-X interface is factory pre-configured for auto-negotiation and flow control enabled. Auto-negotiation and flow control can be disabled via the NMS.

The 10/100Base-T interface ships from the factory with auto-negotiation enabled, and cannot be configured otherwise.

 **Note**	*The radios support all standard Ethernet frame sizes, up to 1632 bytes for un-tagged or 802.1q VLAN-tagged frames.*

5.1 Network Port Statistics

If the capability exists in the network equipment connected to the 80GHz System, verify the following:

- Link integrity
- There are no receive errors on the link
- Network traffic is flowing in both directions

For configuring the radio's Management Agent, please go-to the NMS Manual. It can be found in the product downloads section on-line; http://www.bridgewave.com/support/downloads.cfm

Apendix A Troubleshooting

The following table provides a summary of possible problems you might encounter while installing a BridgeWave 80GHz link, along with possible causes and their solutions.

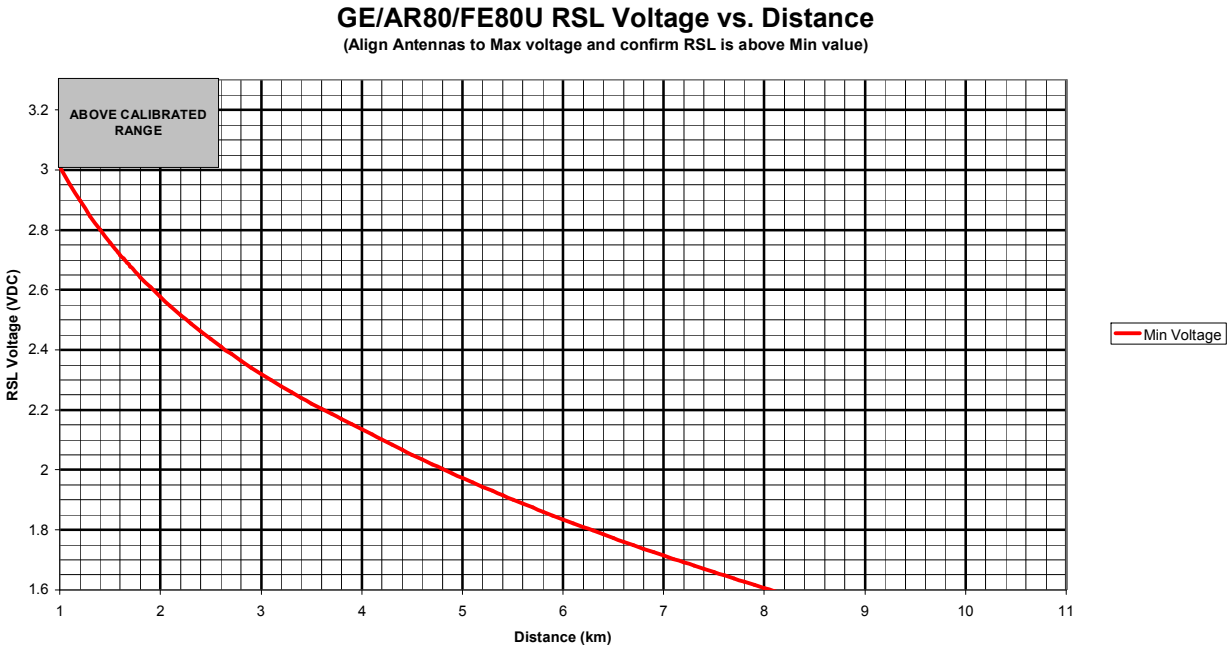
Note	*Extensive troubleshooting support and knowledgebase articles are available at the BridgeWave eSupport knowledgebase online at: http://bridgewave.com/support/kbrma.htm Contact BridgeWave support to obtain a login account.*

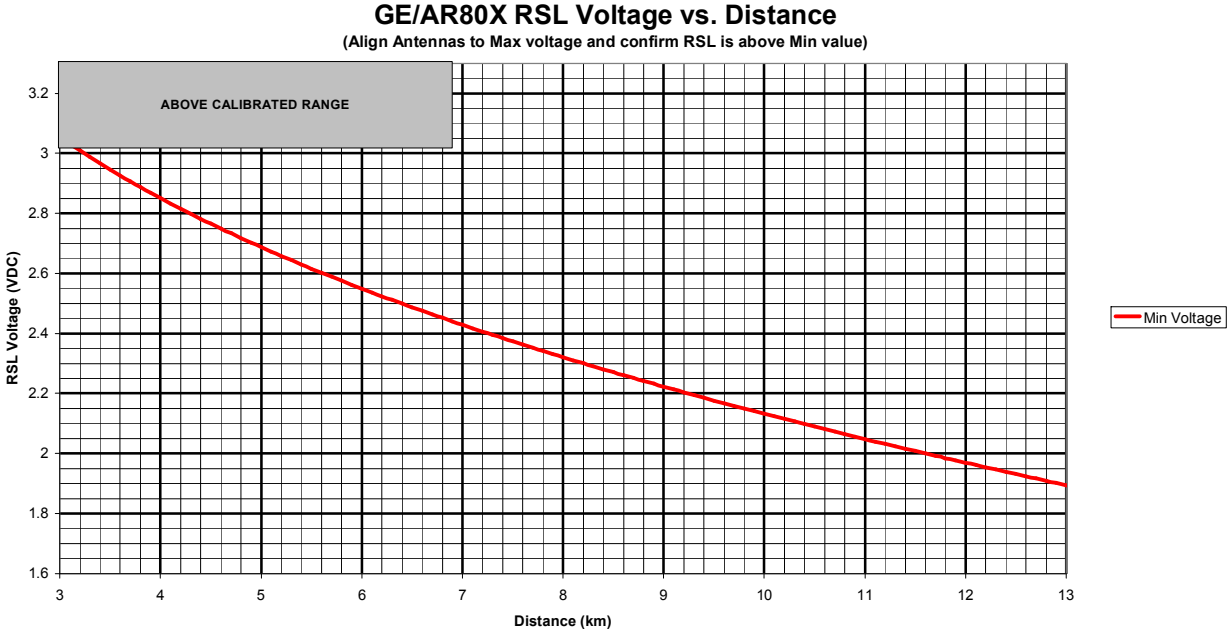
Table A-1: Troubleshooting

Problem	Possible Cause	Resolution
No power to radio	Wrong polarity of supply voltage	Use a DVM to determine the polarity and voltage on the DC cable. (See Section 3.7.2)
	The supply voltage measured at the radio (when connected) is below 15VDC	The cable run is too long or the cable gauge is too small. Shorten the length of the cable or use larger gauge cable. (See section 3.7.2)
Fiber light lit at radio but not on network equipment	Fiber connector not inserted properly	Check fiber connections at radio and at network equipment.
	Inconsistent fiber port configuration between radio unit and connected switch or router.	Verify the configuration of the network equipment. Both ports must either be set to auto-negotiate or each must be set to not auto-negotiate with flow control disabled.
	One or both of the fibers have been damaged	Use a loopback connector at the radio to verify the radio is OK, repeat at the networking equipment. Visually inspect the fiber cable.
	Radio link is down **AND** LSP mode enabled.	Operation normal. Check RF status of both radios and LSP option of both radios NMS Setup tab. Check for rain event or other obstruction in RF path, or radio is out of alignment.
RSL voltage lower then expected	Incorrect calculation of link distance	Verify that the calculation tool used and the GPS used both have the same annotation system (degree hours minutes seconds or degree with a decimal value)

	Antennas aligned on side lobes	Repeat antenna alignment procedure.
	Radios set to different polarizations	Verify that both radios are mounted in the same polarization. (see section 3.6)
	Installed two high or two low band radios in one link	Verify that one end of the link is high and the other end is a low band radio
	Test cable not inserted into test port on radio properly	Ensure test cable is completed inserted into the test port of the radio.
	Make sure that you are using correct RSL voltage table.	If table is for a different product, consult the correct product manual.
Low link quality voltage	Antennas are not aligned for maximum RSL	Verify antenna alignment, use instructions provided in sections 3.6-3.9
	Auto calibration not successfully completed	Repeat auto-calibration procedure.
	Interference	This is unusual unless other radios using the same spectrum are co-located. Check for possible interference by turning off the radio at the other end of the link and verify the RSL voltage on the local site drops below 0.2V .
	Test cable not inserted into test port on radio properly	Ensure test cable is completely inserted into the test port of the radio.
Cannot connect to radio network management agent	Incorrect IP address configuration on radio or PC	Verify Ethernet connections are up, verify IP address, check for IP address conflicts, clear ARP cache on PC, and/or perform hard reset on radio unit (see NMS manual).
	Management agent access is blocked through one or more interfaces	Verify management access configuration on Setup t, and change if necessary. Try accessing agent through other interfaces (fiber, copper, radio link)

Apendix B RSL Vs. Distance Charts





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